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ABSTRACT

A study examined the benefits of investments in the University of Idaho College of Agriculture (UICA) research and extension programs. Data were collected from personal interviews conducted in fiscal year 1986-87 with all principal investigators, co-researchers, and Cooperative Extension Service (CES) subject matter specialists involved in funded research projects in the Idaho Agricultural Experiment Station. It was discovered that UICA research and extension specialists' resources are allocated as follows: 5.1% to services demanded by the public and private sectors, 40.3% to maintenance of the production level achieved by past research, 37.6% to applied research, and 17.0% to long-term basic research. The value of the flow of benefits expected from investment in total research and extension programs was estimated at $881.96 million (excluding the estimated benefits from services rendered by the UICA or the potential benefits from CES consumer- and/or youth-oriented programs). The programs' benefit-cost ratio was calculated at 8.18, and the internal rate of return to total investments in research and extension was calculated at 23.39%. It was estimated that, without CES efforts to identify problems and help research personnel find solutions and implement results, 45% of the benefits from maintenance and applied research cannot be realized. (MN)

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A. A. Araji, Agricultural Economist

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The Benefits of Investments in the University of Idaho College of Agriculture Research and Extension Programs

A. A. Araji, Agricultural Economist

Introduction

The Hatch Act of 1887 created the structure for a federal-state research system to address the problems facing farmers and to build scientific knowledge necessary for the development of the U.S. agricultural industry (Kerr 1987). Called the State Agricultural Experiment Station (SAES), the research system was established in every land-grant institution in the United States.

The Smith-Lever Act of 1914 established the Cooperative Extension Service (CES) and charged it with the primary responsibility of disseminating information and helping farmers to implement technical knowledge gained through agricultural research. The CES is thus the marketing arm of the SAES. Without the work of the CES, many research results fail to reach their intended users. Depending on the type of research, an estimated 25 to 66 percent of research results will not be implemented unless CES transfers those results to users (Araji et al. 1978).

Since the passage of the Hatch and Smith-Lever acts, the land-grant institutions, in partnership with the United States Department of Agriculture, have been the principal developers and disseminators of new agricultural knowledge and evolving technologies. Basic and applied research and related extension work remain the principal functions of the SAES and CES, yet over time the responsibilities of the SAES and the CES have expanded to include maintaining the level of production achieved by past research.

Recent studies have provided evidence of the importance of maintenance research. Blakeslee (1987) estimated that almost 90 percent of recent agricultural research and extension expenditures in the United States are needed to maintain productivity. These estimates are higher than Adusei's (1987), who concludes that maintenance research represents slightly more than one-third of agricultural research aimed at producing agricultural technologies. Araji et al. (1978) estimated that between 10 and 35 percent of scientific time is allocated to maintenance research for selected commodities in the western region. These studies, while differing in methodology and results, suggest that a significant portion of SAES and CES resources is allocated to maintaining the productivity of presently implemented research results.

The responsibility of CES also has expanded since the passage of the Smith-Lever Act. Today it includes consumer-oriented programs, youth-oriented programs, the Expanded Food and Nutrition Education Program and others.

State and federal governments have recognized the importance of research and extension to the development of the agricultural industry by making sizable investments in agricultural research and extension. State governments provide the major portion of appropriated funds for SAES research and for the CES. In Idaho, 63 percent of total annual appropriated funds is contributed by the state; only 16.8 percent is contributed by the federal government. Product sales and grants from private industries account for 20.2 percent of total funds. State and county government appropriations for the University of Idaho CES represent over 76 percent of total annual appropriated funds; less than 24 percent comes from federal appropriations.

Since the mid-1950s, economists have analyzed the economic impacts of investments in agricultural research for a wide range of commodities and countries (Ruttan 1982). University of Idaho researchers have analyzed the benefits of investments in research and extension for selected agricultural commodities in the western region (Araji et al. 1978). Although this approach provides decision makers with important information about

investments in individual commodities, the approach has little meaning for decision makers attempting to evaluate a college's research and extension program as a whole. A more useful approach is to evaluate the economic impacts of the entire research and related extension program.

Most previous studies also have analyzed only the past performance of investments in agricultural research (Ruttan 1982, Araji 1980). Yet research expenditures may occur many years before any economic benefit is realized. Decision makers with responsibility for allocating funds for agricultural research are thus faced with the dilemma of decision making in an uncertain environment.

A frequently asked question is this: Although previous investments in agricultural research have been highly productive, what are the projected economic benefits of present and future funding requests? In this study, an economic model was developed to project the expected economic benefits of total present and future investments in the Idaho Agricultural Experiment Station (IAES) and CES at the University of Idaho College of Agriculture.

Objectives

The objectives of this study were:

1. To ascertain the research focuses of the University of Idaho College of Agriculture,
2. To determine the proportions of research and extension resources allocated to the development and dissemination of basic, applied and maintenance research results and
3. To evaluate the economic benefits of present and future investments in research and related CES programs conducted by the University of Idaho College of Agriculture.

The benefit of CES programs such as consumer- and youth-oriented programs and the Expanded Food and Nutrition Education Program is not easy to quantify. Thus, the economic evaluation of the CES in this study concentrates on the part of the CES responsibility that relates to dissemination and implementation of research results.

Methods

Sources of Data

Data came from personal interviews with all principal investigators, co-researchers and CES subject matter specialists involved in funded research projects in the IAES. The interviews took place during fiscal year 1986-87. For each research project initiated before July 1986, for which results are not yet available, and for those initiated after July 1986, the following information was obtained: Full-time equivalent (FTE)[1] allocation, time required to achieve objectives, probability of research success, time lag between the availability of research results and initial adoption, probability and rate of adoption of research results, expected adoption time profile, resources required to help farmers implement research results, costs to farmers to implement the research results, and duration and impacts of research results on changes in yield, quality and cost of production.

In all cases, interviewees gave high, medium and low estimates for the probability of research success, the probability and rate of adoption of research results and the impact of research results on increasing yield and reducing production cost. This study used the low estimates to minimize potential upward bias in estimating the flow of benefits.

Research and extension personnel also were asked to classify their respective project(s) into one of the following research areas: (1) maintenance research, (2) applied research and (3) basic research. They also estimated scientific time allocated to services demanded by the public and the private sectors.

Research and Extension Costs

Fiscal 1986-87 research and extension costs for each project came from the principal investigators and the financial office in the University of Idaho College of Agriculture. State and federal appropriations for agricultural research in the IAES totaled $8,733,594. The college received an additional $800,000 of research funds from commodity commissions and associations and $4.6 million in grants and contracts. USDA personnel affiliated with the College of Agriculture received an estimated $2.5 million in federal appropriations.

Federal and state appropriations to the University of Idaho Cooperative Extension System totaled $5,894,406 in fiscal year 1986-87. About 58 percent of the extension appropriation was allocated to county extension operations and 4-H programs, and 42 percent was allocated to extension administration and extension subject matter specialists.

Total funding for the IAES and CES from all sources in fiscal year 1986-87 was $22,528,000. Funding for scientists and extension subject matter specialists was $19,121,000 of which $16,633,594 was for research. An annual inflationary rate of 5 percent was allocated to total investment in projects initiated in July 1986. The actual cost of projects initiated before July 1986 was used.

[1]An FTE is the equivalent of one full-time position.

Measure of Benefit

An economic model was developed to estimate the benefits of present and future investments in agricultural research and in extension resources to help farmers and other users implement the results of research (Araji et al. 1978). We calculated several measures of benefit. The *benefit-cost ratio* is defined as the ratio of the present value of expected benefits from implementation of research results to the present value of expenditures. The *internal rate of return* is defined as the rate of return that equates the present value of the flow of expenditures in the development, implementation and maintenance of research results with the present value of the expected flow of benefits from implementing research results. The flow of benefits was based on the probabilities of obtaining and implementing the results for each research project.

The 1986-87 production year served as the base year for calculating changes in production and costs resulting from the implementation of research results. The 1984-86 average price for each affected commodity was used to calculate changes in prices resulting from implementation of research results. A discount rate of 8 percent was used for continuing research initiated before July 1986, for which results are not yet available, and for current research initiated after July 1, 1986.

Results

Research and extension specialists' resources in the University of Idaho College of Agriculture are allocated to four principal functions. An estimated 5.1 percent of the resources are absorbed by services demanded by the public and the private sector, 40.3 percent is allocated to maintaining the level of production achieved by past research, 37.6 percent is allocated to applied research and 17.0 percent is allocated to long-term basic research.

Services

Services provided by research scientists and extension specialists in the University of Idaho College of Agriculture include the following:

- Soil surveys and soil mapping used by such agencies as the U.S. Bureau of Land Management, U.S. Forest Service, U.S. Soil Conservation Service, highway departments and Idaho municipalities.
- Food quality research to help food processors comply with state and federal labeling regulations and to provide data to the USDA's Nutritional Data Bank used by national and international health organizations.
- Development and maintenance of various databases and of techniques for applying and/or interpreting these data to help state and federal agencies institute appropriate policies and regulations on natural resource use, environmental quality, ecological balance and food quality control.

The principal beneficiary of these services is the public sector. Analysis of the economic benefit of these services is difficult because usually there is no market transaction and no easily observed price signal. Thus, it was impossible to calculate the benefits of services rendered by the college's SAES and CES.

Maintenance Research

Scientists and extension subject matter specialists classified the following activities as maintenance research:

- Soil conservation research to maintain present productivity by reducing the loss of topsoil due to wind and water erosion.
- Economic research to analyze the impact of new technology and price relationships on agricultural policies.
- Pest control research for maintaining present productivity including (a) surveys of insect populations and determinations of infestation levels, (b) tests of new pesticides and herbicides to replace present, less-effective ones, (c) searches for replacements for chemicals banned or scheduled to be banned by the U.S. Environmental Protection Agency and (d) control of pests on large acreages of rangeland.
- Research in such areas as (a) cultural practices, (b) pest and disease control during storage, (c) discovery and control of natural toxicants in the food chain, (d) environmental stress research to maintain yield and quality, and (e) information management.

Applied Research

The distinction between applied research and maintenance research often is unclear. However, experiment station scientists and extension specialists identified applied research as research that uses presently available knowledge and directs it toward the following general areas: (1) reducing present losses and costs, (2) improving the productivity of presently adopted research and (3) developing new products and/or enhancing the growth and development of specific segments of the agricultural industry.

Research and extension programs in the first applied category include:

- Improvement of feed efficiency, reduction of death loss and improvement of livestock conception rates, development of a coordinated pest management program that includes selection of resistant varieties and development of biological control methods to reduce reliance on chemicals and the cost of pest control.

- Development of a fertilizer management system that will increase fertilizer use efficiency, improve product quality and increase yields.
- Development of an efficient water management system, including the design of low-cost, efficient irrigation systems and improved pumping efficiency.
- Reduction of post-harvest loss by the development of more-efficient mechanical handling, transportation and storage practices.
- Transfer to farms of management and marketing information for efficient resource use, thus reducing their production and marketing costs.

Programs in the second applied category deal primarily with breeding and varietal improvement research aimed at improving the yield and quality of presently grown varieties and with developing new varieties that are resistant to specific pests or environmental stress.

Programs in the third category include research directed toward the development of alternative enterprises, toward international market development and strategies and toward increasing the comparative advantage and economic viability of specific crops such as small grains and alfalfa, grass and vegetable seeds.

Basic Research

Basic research, as defined by scientists in the area, is directed toward the development of new knowledge to solve problems that presently available scientific knowledge cannot solve. Basic research programs conducted by scientists in the University of Idaho College of Agriculture include:

- Development of a gene marking system to link to disease resistance and quality.
- Research in gene design, embryo physiology and growth regulators intended to provide animal and plant breeders with basic information for selecting more efficient breeds of animals and for breeding and selecting plant varieties that are high yielding, more vigorous, less energy demanding and resistant to diseases and environmental stress.
- Bioengineering research to convert processing wastes into useful protein supplements and to reduce disposal costs.
- Biomass conversion research to convert wheat, barley and corn straw and potato processing waste into polyphenols and amino acids.
- Identification of hormones that regulate the feeding and egg laying behaviors of insects in order to develop effective biological controls.

Economic Impacts

The estimated present value of the flow of benefits expected from investment in total research and extension programs is $881.96 million (Table 1). This estimated benefit does not include the benefits from services rendered by the University of Idaho College of Agriculture or the potential benefits from CES consumer-oriented programs, youth-oriented programs or the Expanded Food and Nutrition Education Program.

The benefit-cost ratio (the total dollars in revenue generated from each dollar invested in total research and extension programs) is 8.18. The cost includes all research and extension expenditures, administration costs, maintenance costs on buildings and equipment incurred by the College of Agriculture and the cost of implementing the research results paid by the end users.

The internal rate of return to total investments in research and extension is 23.39 percent. In other words, every dollar invested in the total research and extension program is recovered plus an additional 23.39 cents.

The University of Idaho CES is the marketing arm of the IAES. Without extension programs to transfer research results and help agricultural firms to implement them, most potential benefits from agricultural research cannot be realized. This study indicates that an average of 45 percent of the benefit from maintenance and applied research cannot be realized without CES efforts to identify the problem and help research personnel to find solutions and implement results.

Table 1. Return to total investments in the Idaho Agricultural Experiment Station and the University of Idaho Cooperative Extension System.

Measures of benefit	
Present value (millions of dollars)	$881.96
Net present value (millions of dollars)	$774.17
Benefit/cost ratio	8.18
Internal rate of return (percent)	23.39

Summary

One task of the University of Idaho College of Agriculture is to promote economic growth by introducing technical change. Technical change leads to efficient use of resources in the production, storage, processing and distribution of food and fiber products. Investments in research conducted by the University of Idaho Agricultural Experiment Station have resulted in the development of new knowledge and evolving technologies. Investments in the University of Idaho Cooperative Extension System have resulted in the implementation of new technologies by farmers, food processors and other agricultural firms. In general, investments in research and extension by the land-grant institutions and the U.S. Department of Agriculture have been the cornerstone for the development and growth of the agricultural sector of the United States economy.

State governments carry the major burden of appropriating funds for agricultural research and extension. In Idaho, 63 percent of the total funds appropriated annually for agricultural research is contributed by the state. State government appropriations for extension make up 76 percent of total appropriated funds.

We developed a computer program to estimate the benefits of present and future investments in the Idaho Agricultural Experiment Station and the University of Idaho Cooperative Extension System. The program shows that investment in total research and extension programs is expected to produce benefits with a present value of $881.96 million. The internal rate of return to investments in research and extension programs, including administration and maintenance costs, is estimated at more than 23 percent. This rate of return does not include the benefits of services rendered to public and private sectors or any potential benefits from such extension programs as consumer-oriented programs, youth-oriented programs, the Expanded Food and Nutrition Education Program and others for which calculation of benefit was impossible. As such, 23 percent is a conservative estimate. In general, this rate of return, which includes the cost of implementing and maintaining the productivity of research results, is high and compares favorably with the rates of return to most investments.

This study also shows that research and extension resources in the University of Idaho College of Agriculture are allocated to four major areas. An estimated 5.1 percent of the resources is absorbed annually by services demanded by the general public and by state and federal agencies. Research into maintaining the level of production achieved by past research is the major research area, accounting for 40.3 percent of annual research and related extension expenditures. Applied research is the second major research area, accounting for 37.6 percent of annual research and related extension expenditures. Investment in long-term basic research accounts for 17.0 percent of annual research expenditures. Basic research provides new information that is essential for conducting applied research.

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